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Cardiff Road
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1. Your reference — P34813-/SSI/CCI/GEM

2. Patent application number *(The Patent Office will fill in this part)* — 0319172.3 — 15 AUG 2003

3. Full name, address and postcode of the or of each applicant *(underline all surnames)* — The Court of Napier University
10 Colinton Road
Edinburgh
EH10 5DT

Patents ADP number *(if you know it)* — 77524390003

If the applicant is a corporate body, give the country/state of its incorporation — United Kingdom

4. Title of the invention — "Support Beam"

5. Name of your agent *(if you have one)* — Murgitroyd & Company

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)* — Scotland House
165-169 Scotland Street
Glasgow
G5 8PL

Patents ADP number *(if you know it)* — 1198015

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
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Yes

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Description	15
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Abstract	-
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10. If you are also filing any of the following, state how many against each item.

Priority documents	-
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Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	-
Request for preliminary examination and search *(Patents Form 9/77)*	-
Request for substantive examination *(Patents Form 10/77)*	-
Any other documents *(please specify)*	-

11. I/We request the grant of a patent on the basis of this application.

Signature Murgitroyd & Co. Date 15 August 2003

Murgitroyd & Company

12. Name and daytime telephone number of person to contact in the United Kingdom — Edward Murgitroyd — 0141 307 8400

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Structural Support Beam

This invention relates to a structural support beam manufactured from a composite of materials, and in particular, but not exclusively, to a composite of timber in various forms with an infill of material that provides both added structural support and thermal/sound insulation, for use in the building and construction industry.

Support beams of the form of Laminate Veneer Lumber (LVL), Parallam products, Glulam products, I-joists and Box Beams, are known. These different support beams offer different structural properties and are used in different designs for different applications, for example, Parallam products have a high stiffness and strength compared to the other above-mentioned beams, but are heavier, more abrasive to saw and drill, require connection be made to adjacent beams with metal plates and bolts or dowels rather than nails, and are relatively costly; LVL products provide strength and consistent

performance, are easy to work with, can be cut and nailed on site, resist shrinkage, warping, splitting and checking, but are relatively costly.

Box beams are also known as shown in Fig.1. These typically consist of solid timber or LVL flanges with plywood or Orientated Strand Board (OSB) webs. The webs are glued and/or mechanically connected to the flanges on each side to form a box shape.

Box beams are moderately lightweight and can be handled easily, allow a higher load capacity than comparable sized timber, resists shrinkage, warping and checking, and are more efficient than solid timber for large spans and loads.

However, such box beams are susceptible to shear buckling requiring web stiffeners to be positioned at points of increased load to counter localised web buckling. Furthermore, holes in the web should only be located where shear loads are low.

According to a first aspect of the present invention there is provided a structural support beam for use in construction and building comprising a support frame defining a volume, the support frame being of a first material, the volume having an infill of a second material, bonded to the support frame.

Preferably, the second material is substantially less dense than the first material.

Preferably, the frame is timber. "Timber" is used herein to denote solid and laminated timber, and also timber products such as plywood and Orientated Strand Board (OSB).

Preferably, the second material is a plastic foam that behaves as an insulator and provides additional structural properties.

Alternatively, the second material may be of any other type that behaves as an insulator and provides additional structural properties.

Preferably, the frame is of the form of an I-beam or box beam.

Preferably, the frame consists of at least two substantially horizontal flanges connected at respective ends of at least two substantially vertical webs.

Further webs may be located between the frame for increased structural properties.

Preferably, the flanges are of solid or laminated timber and the webs are of timber sheet material.

According to a second aspect of the present invention there is provided a method of manufacture of said structural support beam, said method comprising the steps of:

attaching at least two webs to at least two flanges to form a frame of a first material defining a volume; and

said volume being filled with an infill of a second material bonded to the frame.

Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:-

Fig. 1 is a side sectional view of a known box beam;

Fig. 2 is a side sectional view of a support beam made in accordance with the present invention;

Figs. 3a-b are side sectional views of the apparatus of Fig. 2 with additional horizontal flanges to form an I-beam showing fasteners visible from the outside, and not visible from the outside, respectively;

Figs. 4a-b are side sectional views of the apparatus of Fig. 2 with additional horizontal flanges to form a box beam showing fasteners visible from the outside, and not visible from the outside, respectively;

Fig.5 is a side sectional view of the apparatus of Fig. 2 with an additional support web;

Figs. 6a-b are side sectional views of the apparatus of Fig. 2 with an additional support web connected to one and both of the outer face(s) respectively of the apparatus of Fig. 2;

Fig. 7 is a side sectional view of an alternative support beam having T-flanges to form an I-beam;

Fig. 8 is a side sectional view of the apparatus of Fig. 7 in the form of a box beam;

Fig. 9 is a side sectional view of the apparatus of Fig. 7 with adapted flanges;

Fig. 10 is a side sectional view of the apparatus of Fig. 9 with further adapted flanges;

Fig. 11 is a side sectional view of an alternative support beam in the form of an I-beam;

Fig. 12 is a side sectional view of the apparatus of Fig. 11 having additional supports;

Fig. 13 shows side sectional views of adapted embodiments of the present invention: (a) is the apparatus of Fig. 2 with metal plates added; (b) is the apparatus of Fig. 2 having

further flanges with metal plates located at either end of said apparatus forming an I-beam; (c) is an alternative arrangement to (b); (d) is the apparatus of Fig. 8 with metal plates located on the flanges; (e) is the apparatus of Fig. 9 with metal plates located on the flanges; (f) is the apparatus of Fig. 5 adapted with additional flanges having metal plates;

Fig. 14 is a comparison of the load-deformation behaviour of a sample of embodiments made in accordance with the present invention under direct compression loads; and

Fig. 15 is a qualitative table comparing known support beams to the present invention.

Referring to the drawings, Fig. 1 shows a known box beam 10 consisting of horizontal flanges 16, 18 connected between respective ends of two opposing vertical webs 12, 14 to form a box shape. Typically, the webs 12, 14 are glued to the flanges 16, 18 and/or mechanically connected to aid fabrication.

In a first embodiment of the present invention, as shown in Fig. 2, there is a structural support beam in the form of a box beam 100 comprising two horizontal flanges 116, 118 connected between respective ends of two opposing vertical webs 112, 114 to form a support frame in the shape of a box.

The webs 112, 114 are glued and or mechanically connected to the flanges 116, 118. Typically, the flanges are of solid sawn timber, glulam or LVL, and the webs are of a timber sheet product such as plywood or Orientated Strand Board (OSB).

The box beam 100 further includes an infill of support/insulating material 110 within a volume defined by the webs 112, 114 and flanges 116, 118.

The material 110 is a plastic foam, for example, expanded polystyrene (EPS), extruded polystyrene, urethane, or other similar insulation cores that is bonded to the webs 112, 114 and flanges 112, 114 to form a close contact. However, the material 110 may be of any type to improve both the insulation and/or structural properties of the box beam 100.

In a second embodiment of the present invention, as shown in Figs. 3a-b, there is a structural support beam in the form of an I-beam 200 comprising substantially the same box beam 100 as described above with the addition of further flanges 220, 222 (which will be referred to as I-flanges) being connected to flanges 116, 118 (which will be referred to as box-flanges) to form a support frame that is I-shaped. The I-flanges 220, 222 are glued and/or mechanically connected to the box-flanges 116, 118. Mechanical connectors can either be located through the I-flanges to the box-flanges as shown in Fig. 3a or can be located from the box-flanges to the I-flanges as shown in Fig. 3b so as

not to be seen from the outside on the outer face of the I-beam 200.

In a third embodiment of the present invention, as shown in Figs. 4a-b, there is a structural support beam in the form of a box beam 300 comprising substantially the same box beam 100 as described above with the addition of further flanges 320, 322 (referred to as flush-flanges) being connected flush with the respective flange ends of the box beam 100 to form a support frame in the shape of a box. The flush-flanges 320, 322 are glued and/or mechanically connected to the box-flanges 116, 118. Mechanical connectors can either be located through the flush-flanges to the box-flanges as shown in Fig. 4a or can be located from the box-flanges to the flush-flanges as shown in Fig. 4b so as not to be seen from the outside on the outer face of the box beam 300.

In a fourth embodiment of the present invention, as shown in Fig. 5, there is a structural support beam in the form of a box beam 400 comprising substantially the same box beam 100 as described above with the addition of a further vertical web 424 connected between each flange 416, 418 within grooves 426, 428, and between webs 112, 114 to form a support frame in the shape of a box. The web 424 may be rigidly fitted within the grooves 426, 428 and/or glued and/or mechanically connected.

In a fifth embodiment of the present invention, as shown in Figs. 6a-b, there is a structural support beam in the form of a box beam 500 comprising substantially the same box beam 100 as described above with the addition of support webs 513, 515 being connected at outer ends of the box beam 100 to the vertical webs 112, 114. One support web 513 or 515 can be glued and/or mechanically connected to one of the webs 112, 114, Fig. 6a, or two support webs 513, 515 can be glued and/or mechanically connected to both webs 112, 114.

In a sixth embodiment of the present invention, as shown in Fig. 7, there is a structural support beam in the form of an I-beam 600 comprising two T-shaped flanges 616, 618, one of them being inverted, connected between the respective ends of two vertical webs 612, 614 to form a support frame that is I-shaped. The vertical webs 612, 614 can be glued and/or mechanically connected to the vertical portions of the T-shaped flanges 616, 618. The webs 612, 614 and flanges 616, 618 define a volume having an infill of support/insulating material 610 substantially the same as material 110 as hereinbefore described.

In a seventh embodiment of the present invention, as shown in Fig. 8, there is a structural support beam in the form of a box beam 700 comprising two T-shaped flanges 716, 718, one of them being inverted, connected flushly between respective ends of two vertical webs 712, 714 to form a support frame that

is box shaped. The vertical webs 712, 714 can be glued and/or mechanically connected to the T-shaped flanges 716, 718. The webs 712, 714 and flanges 716, 718 define a volume having an infill of support/insulating material 710 substantially the same as material 110 as hereinbefore described.

In an eighth embodiment of the present invention, as shown in Fig. 9, there is a structural support beam in the form of an I-beam 800 comprising two horizontal flanges 816, 818 connected between two vertical webs 812, 814 to form a support frame that is I-shaped. The vertical webs 812, 814 are located within grooves 824a-826b of the flanges 816, 818. The webs 812, 814 may be rigidly fitted within grooves 824a-826b and/or glued and/or mechanically fastened to the flanges 816, 818. The webs 812, 814 and flanges 816, 818 define a volume having an infill of support/insulating material 810 substantially the same as material 110 as hereinbefore described.

In a ninth embodiment of the present invention, the I-beam 800 has been adapted to form a new structural support beam or I-beam 900, wherein, the grooves 824a-826b of the flanges 816, 818 have been replaced by recesses 925, 927 with an infill of support/insulating material 910 substantially the same as material 110 as hereinbefore described, Fig. 10.

In a tenth embodiment of the present invention, as shown in Fig. 11, there is a structural support beam in the form of an I-beam 1000 comprising two horizontal flanges 1016, 1018 connected between respective ends of two vertical webs 1012, 1014 to form a support frame that is I-shaped. The webs 1012, 1014 and flanges 1016, 1018 define a volume having an infill of support/insulating material 1010 substantially the same as material 110 as hereinbefore described.

In an eleventh embodiment of the present invention, the I-beam 1000 has been adapted to form a new structural support beam or I-beam 1100, wherein, supports 1101-1104 are glued and or mechanically connected to the outer ends of the webs 1012, 1014 and to the flanges 1016, 1018, Fig. 12.

It is to be appreciated that any of the above embodiments can be adapted or modified to include any part of one of the designs from one embodiment to another, by way of example only, Fig. 5 shows a support web which can easily be incorporated into any of the other embodiments.

This description is not to be limited to the designs of the drawings as any one of the embodiments can easily be modified or adapted for improved structural properties with another embodiment. Fig. 13 shows how some of the embodiments may be fitted with metal plates for improved structural properties.

It is to be further realised that the present invention incorporates both structural support and insulation into a single apparatus during manufacture. This enables high quality, more accurate thermal and/or sound efficiency and an increased level of structural support may be achieved.

The present invention can also be produced in varying sizes and thickness depending on the application and insulation/structural requirements. The material 110-1010 not only provides thermal and sound insulation, but also provides increased structural properties of the present invention as shown in Fig. 14; the results of which will now be described in detail.

A sample of the above described embodiments have been tested (under static compression) to establish their structural properties. The apparatus tested was:

(A) and **(B)** which are the apparatus of Fig 1 with and without the infill of material respectively;

(C) and **(D)** which are the apparatus of Fig. 9 with and without the infill of material respectively;

(E) and **(F)** which are the apparatus of Fig. 5 with and without the infill of material respectively; and

(G) and **(H)** which are the apparatus of Fig. 4a/4b

with and without the infill of material respectively.

For all apparatus, corresponding flanges were cut from Whitewood grade C16 timber. The corresponding webs were cut from 11mm thick OSB grade 3 panels and the infill material was 95mm thick expanded polystyrene (EPS). All contact surfaces were glued together, and where appropriate, were screwed using 2x8 woodscrews.

In comparing the apparatus with the infill of material (A, C, E and G) and without the infill of material (B, D, F and H), there is generally an increase in the ultimate load capacity and ductility of the apparatus with the infill of material.

This is advantageous as the infill material will add very little weight to the apparatus overall, yet provides increased ultimate load capacity.

Furthermore, the requirement for I-beams and box beams to have web stiffeners at areas of localised buckling, may be mitigated due to the increased ultimate load capacity of the apparatus with the addition of the infill of material.

Moreover, the results show that the apparatus with the infill of material (A, C, E, G) can carry the same load for an increased deflection, i.e. enhanced ductility.

With particular reference to apparatus (C) and (D), the infill of material in apparatus (C) exhibits an interesting quality. It would appear that the infill of material may also affect the failure mode of the apparatus, for example, apparatus (D) appears to fail at a displacement of 4mm. Apparatus (C) appears to initially fail at 5mm yet can still take the load applied for a further 4mm of displacement. This shows the level of enhanced ductility provided by the infill material of apparatus (C).

Overall the results by far show that the addition of a support web connected between the flanges within the infill of material exhibit a far higher ultimate load capacity. This result may be extrapolated such that the ultimate load capacity of any design can be increased by adding support web(s).

Having conducted the above tests, Fig. 15 shows a qualitative comparison of the present invention (CIB Beams) to the prior art designs.

The infill of material 110-1010 may be pre-fabricated, in which case, the respective webs and flanges of a support frame may be bonded directly to said pre-fabricated material 110-1010.

Alternatively, the material 10-1010 may be injected into a volume defined by a support frame of webs and flanges, wherein the material expands to fill the volume. The respective contact surface of the support frame may have bonding means to assist on

securing and ensuring a close contact with the infill of material 10-1010 to the support frame.

The present invention can be used in all buildings and constructions.

Modifications and improvements may be made to the above without departing from the scope of the present invention.

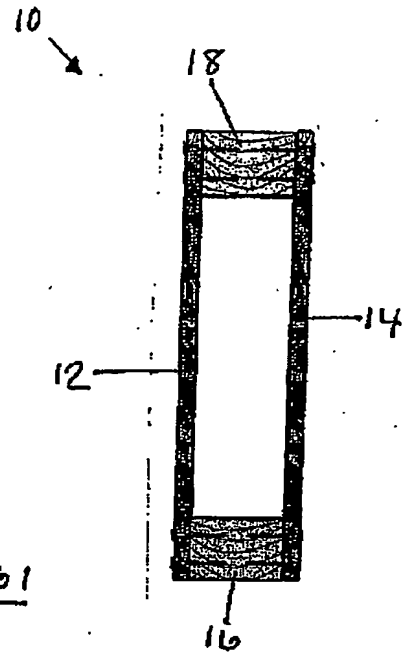

FIG 1

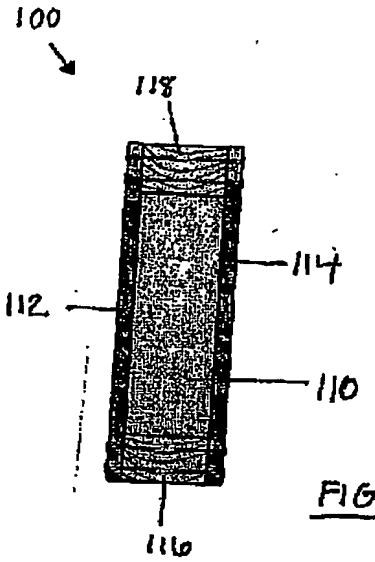

FIG 2

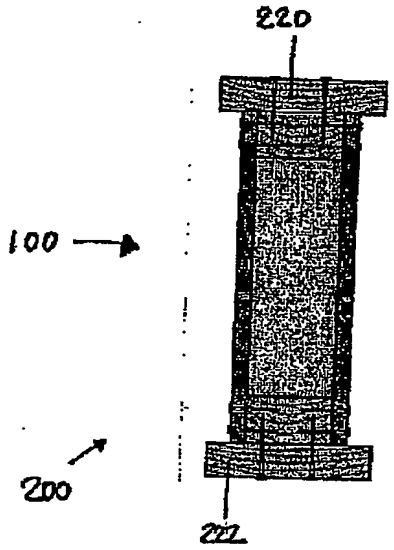

FIG 3A

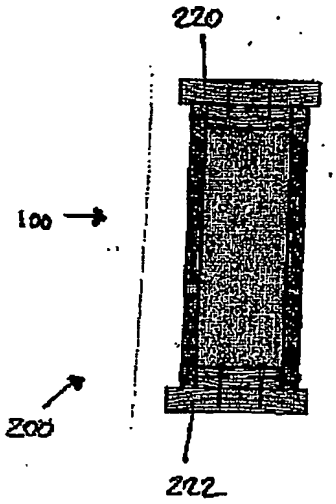

FIG 3B

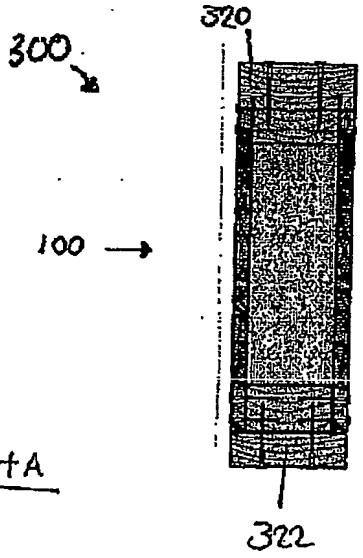

FIG 4A

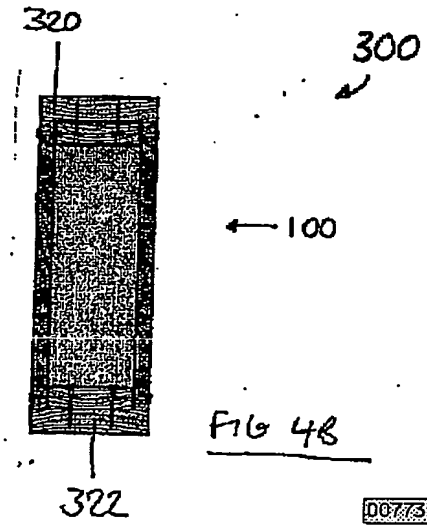

FIG 4B

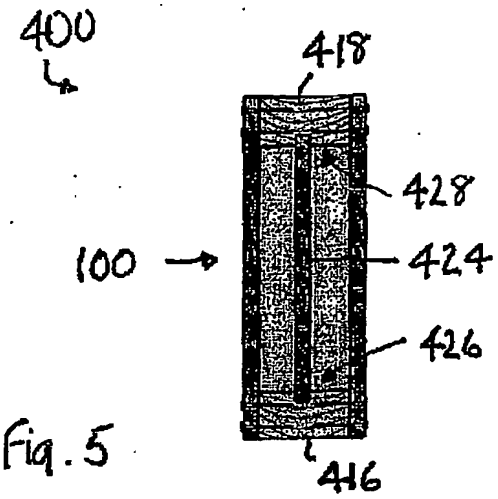

Fig. 5

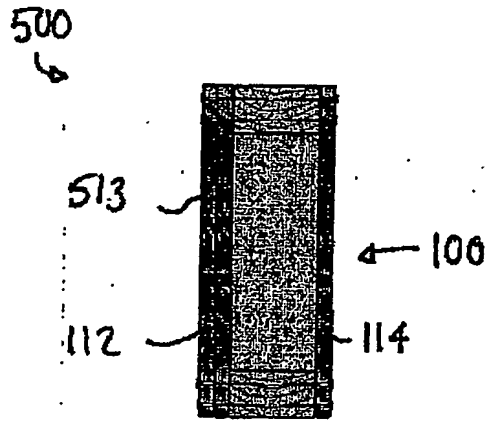

Fig. 6a

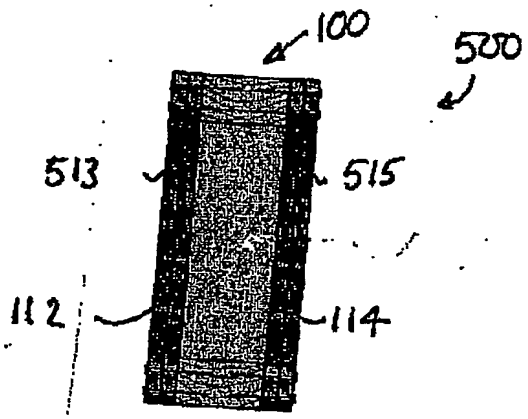

Fig. 6b

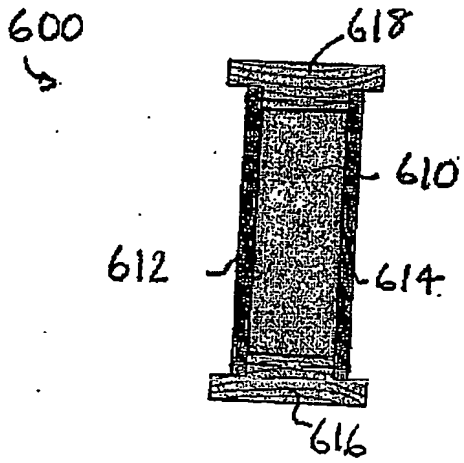

Fig. 7

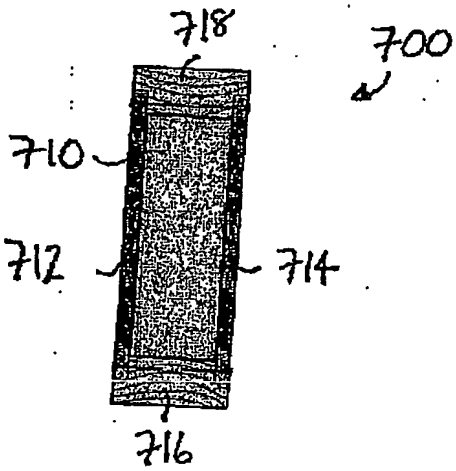

Fig. 8

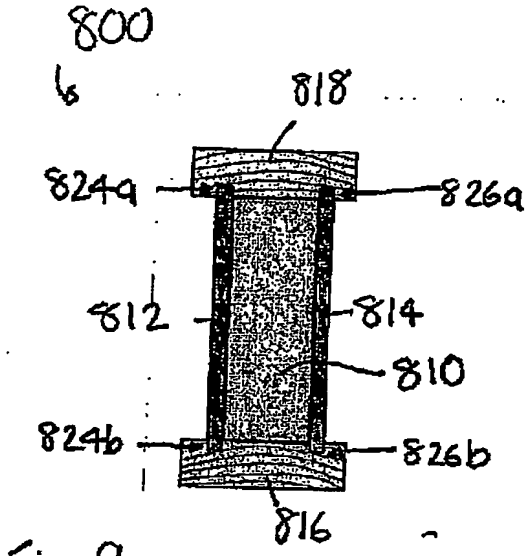

Fig. 9

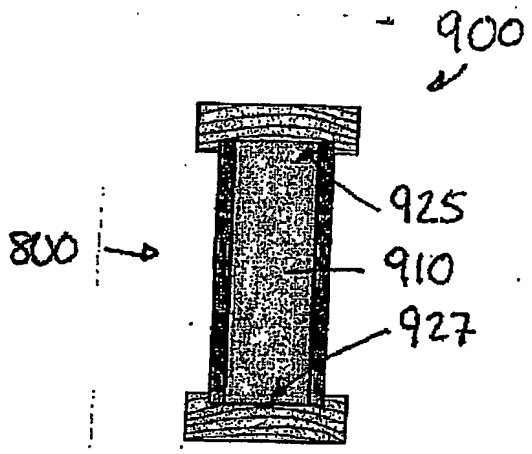

Fig. 10

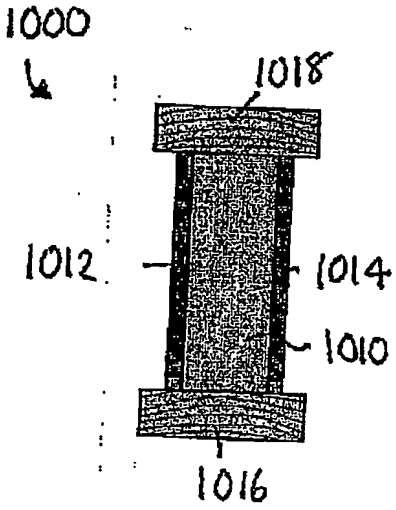

Fig. 11

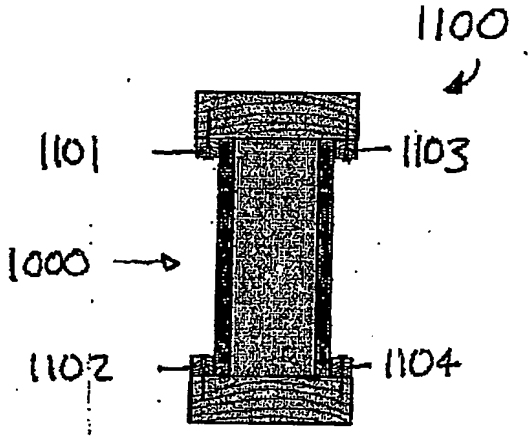

Fig. 12

415

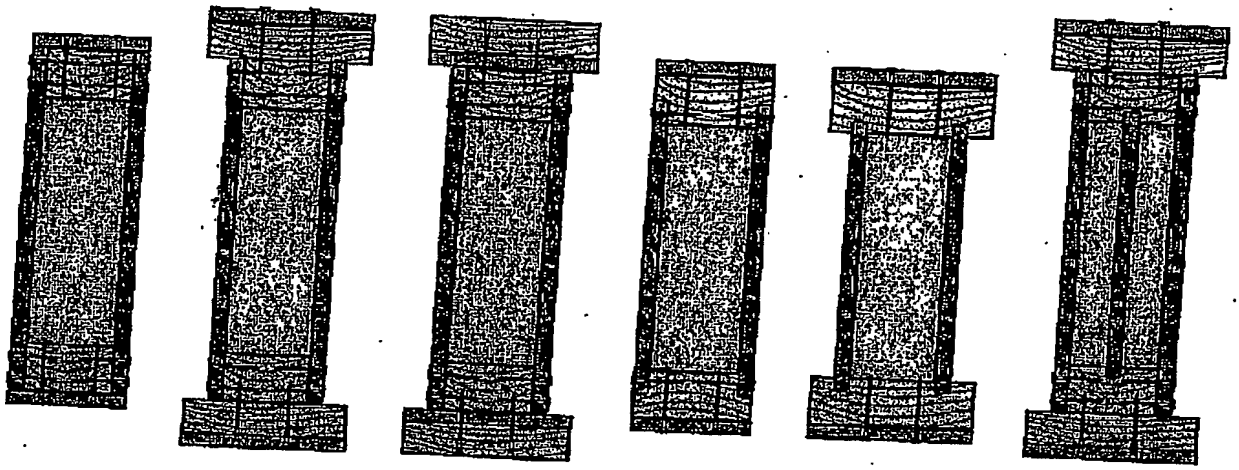

Fig. 13

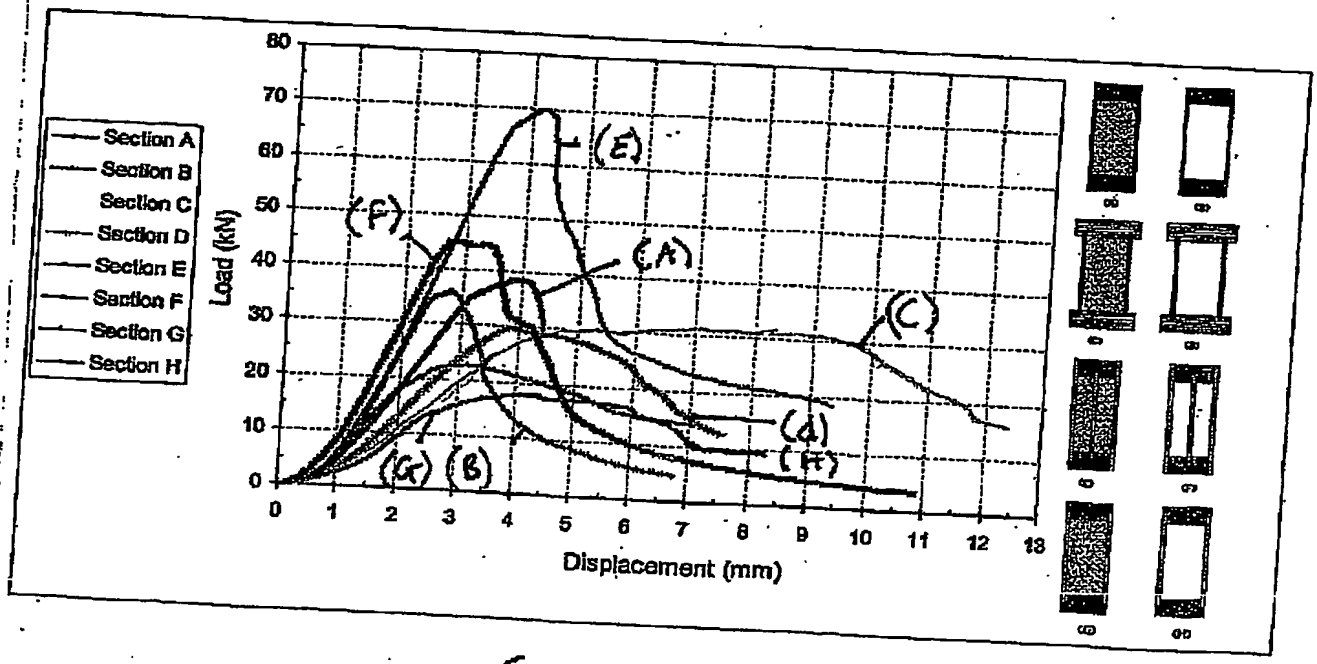

Fig. 14

515

Criterion	LVL	Parallam	Glulam	I-Joist	Box Beam	CIB-Beam
Span	2	1	2	0	2	
Strength	1	2	2	1	0	
Stiffness	1	2	1	1	1	
Appearance	2	2	2	0	1	
Weight	0	0	0	2	2	
Environment issue	-1	-1	0	0	1	
Cost	-2	-2	-2	1	2	
Connectability	2	2	2	0	1	
Easy to work	2	2	2	-1	1	
Size limitation	2	1	2	0	2	
Dimensional stability	2	2	2	0	-1	
Availability	0	0	2	2	1	
Total	11	11	15	6	13	

Indicators are: -2 is the most negative and +2 is the most positive.

Fig. 15